APPLICATION FOR PATENT

INVENTOR

DANIEL WATSON

TITLE:

CRYOGENICALLY TREATED DRILLING AND MINING EQUIPMENT

CERTIFICATE OF EXPRESS MAIL

I hereby certify that this correspondence is being deposited with the United States Postal Service as "Express Mail Post Office to Addressee" Express Mail No. **EV 197 780 993 US** in an envelope addressed to MAIL STOP PATENT APPLICATION; Commissioner for Patents; PO Box 1450; Alexandria, VA, 22313-1450, on the following date: February 20, 2004

Christian Heausler

SPECIFICATION

FIELD

[0001] The present embodiments relate to drilling or mining equipment treated by a thermal process to improve the structural characteristics of the equipment.

BACKGROUND

[0002] The present application claims priority to co-pending U.S. Provisional Patent Application Serial No. 60/511,502 filed on October 14, 2003.

[0003] A need exists for a process to treat equipment and similar devices of manufacture in order to increase their structural characteristics. For example, in the manufacture of drilling equipment, tools and tool components, machinery, engine parts, wear surfaces, bearings, and like articles from various steels and materials that are used for high wear applications.

[0004] A number of thermal type processes are known in the metallurgical arts to enhance the properties of manufacturing materials, such as steels and the like. One widely used class of such metallurgical processes generally known as quenching typically involves forming an article of the desired metal containing material and then rapidly lowering the temperature of the article followed by a return of the article to ambient temperature. The problem with the current processes is that they are usually uncontrolled and result in over-stressing the material and even fracturing the material rendering it useless.

[0005] A further enhancement process for manufacturing materials, such as steel, is in the formation of a nitride containing layer on the surface of an article of the metal containing material that case hardens the material by forming nitrides such as metal nitrides at or near the surface of an article. The formed nitride surface layer may include extremely hard compounds containing nitrides such as CrN, Fe_2N, Fe_3N and Fe_4N. The formed nitride layer tends to create compressive stresses that improve the

properties of the metal containing material, but can also lead to distortions in the article being treated.

[0006] A need has long existed for drilling and mining equipment that is stronger, less brittle and tougher than current equipment.

[0007] A process has long been needed to provide improved drilling, mining, earth moving, and subsea working equipment.

SUMMARY

[0008] The piece of drilling equipment is created by placing the piece of drilling equipment is made by placing the equipment within a thermal control apparatus. The thermal control apparatus has a chamber, wherein the chamber temperature is closely regulated. A first cryogenic material is introduced into the thermal control apparatus decreasing the device temperature while preventing over-stressing of the device. The temperature of the device is reduced to a first target temperature ranging from -40 degrees F and -380 degrees F at a first temperature rate ranging from 0.25 degrees F per minute and 20 degrees F per minute. When the first target temperature is reached, the cryogenic material is no longer introduced into the chamber. The chamber temperature is, then, increased to a second target temperature ranging from 0 degrees F and 1400 degrees F at a second temperature rate ranging from 0.25 degrees F per minute and 20 degrees F per minute. The first cycle results in an intermediate device.

[0009] The second cycle begins by introducing a second cryogenic material into the thermal control apparatus decreasing the temperature of the intermediate device while preventing over-stressing. The temperature is decreased to a third target temperature ranging from -40 degrees F and -380 degrees F at a third temperature rate ranging from 0.25 degrees F per minute and 20 degrees F per minute. When the second target temperature is reached, the cryogenic material is no longer introduced into the chamber. The temperature of the chamber is increased to a fourth target temperature

from 0 degrees F and 1400 degrees F at a fourth temperature rate ranging from 0.25 degrees F per minute and 20 degrees F per minute. The result of the process is a piece of drilling equipment without fractures and enhanced structural characteristics.

BRIEF DESCRIPTION OF THE DRAWINGS

[00010] The present piece of drilling equipment will be explained in greater detail with reference to the appended Figures, in which:

[00011] FIG 1 is a diagram of the steps of the method for treating drilling and mining equipment;

[00012] FIG 2 depicts a cross section of the chamber used in the process; and

[00013] FIG 3 is a diagram of the steps of producing a thermally treated device by a thermal process using three thermal cycles.

[00014] The present piece of drilling equipment is detailed below with reference to the listed Figures.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[00015] Before explaining the present piece of drilling equipment in detail, it is to be understood that the piece of drilling equipment is not limited to the particular embodiments herein and it can be practiced or carried out in various ways.

[00016] An embodiment relates to various types of drilling and mining equipment including drill bits that are cryogenically treated, inserts for use in roller cone drill bits, mining equipment, and earth moving equipment.

[00017] An embodiment also relates to the production of equipment used in drilling and mining operations.

[00018] FIG 1 provides the steps of producing drilling equipment by a thermal process. The first step involves placing a device such as a drill bit, or pump, into a thermal control apparatus (110).

[00019] FIG 2 depicts a cross sectional view of the thermal control apparatus (12) that comprises a chamber (14). The device (10) is placed within the chamber (14). In the embodiment of FIG 2, cryogenic material (18) is introduced to the thermal control apparatus (12), such as through a valve (26) such that the temperature of the chamber (14) increases or deceases depending on whether the valve (26) is on or off. The temperature of the chamber (14) is closely regulated.

[00020] The thermal control apparatus (12) can further include a heat exchanger (16) located within the chamber (14) to provide a cryogenic vapor (20) to the chamber (14). The cryogenic material (18) is released into the heat exchanger (16) thereby absorbing heat from the chamber (14) into the heat exchanger (16) forming a cryogenic vapor (20) that fills the chamber (14). Examples of cryogenic vapors contemplated in this invention are hydrogen, nitrogen, oxygen, helium, argon, and combinations thereof.

[00021] The chamber used in the thermal process can be a double-walled insulated chamber, a vacuum chamber, and a vacuum-insulated chamber. Computer control (22) of the cryogenic process consists of a dedicated microprocessor unit (24) that controls injection of the cryogenic material (18) via a solenoid-operated valve (26). Thermocouples (28a and 28b) provide real-time temperature measurement, and feedback to the microprocessor (24), which then follows the programmed temperature targets and rates.

[00022] Continuing with FIG 1, a first cryogenic material in introduced to decrease the material temperature of the device material while preventing the overstressing of the device (120). In a preferred embodiment, the cryogenic material is used to decrease the device temperature to a first target temperature that ranges from -40° F to -380° F at a temperature rate of change ranging from 0.25° F per minute to 20° F per minute (130).

[00023] The device can be drill bits, bearings, pumps, engines, drill stem, casing, borers, grinders, bucket teeth, hammers, grinders, cutting teeth, actuators, and combinations of these devices. In addition, the device can be any device that experiences wear and tear during any mining process.

[00024] The device can also be any device that is used to move earth material in association with mining and drilling operations. As an optional next step, once the device reaches the first target temperature, the device can soak at this first target temperature for a period of time ranging from 15 minutes to 96 hours. The range can optionally range from 1 minute to 15 minutes and for periods of time from 96 hours to 180 hours.

[00025] Returning to FIG 1, the method continues by stopping the introduction of the cryogenic material into the chamber once the first target temperature is reached (140). The chamber temperature is then increased to a second target temperature ranging from 0 degrees F to 1400 degrees F (150). The device temperature is also increased to the second target temperature at a second temperature rate (160). The second temperature rate ranges from 0.25 degrees F per minute to 20 degrees F per minute. The result is an intermediate device with an intermediate device temperature (170).

[00026] Optionally, the intermediate device can be permitted to soak at the second target temperature for a period of time that ranges from 15 minutes to 48 hours. The soaking at the second temperature can vary from less than 15 minutes to about 1 minute and up to 2 weeks. The preferred aging process at the elevated temperature may be as short as 4 days to relieve the stress in the device.

[00027] Continuing with FIG 1, a second cryogenic material, which may differ from the first cryogenic material, is introduced into the thermal control apparatus decreasing the intermediate device temperature while preventing over-stressing of the intermediate device (220). The temperature is reduced to a third target temperature ranging from -40 degrees F to -380 degrees F at a third temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute (230). The method continues by stopping

the introduction of the cryogenic material into the chamber once the third target temperature is reached (240).

[00028] The chamber temperature is, then, increased to a fourth target temperature ranging from 0 degrees F to 1400 degrees F (250). The intermediate device temperature is, thereby, also increased to the fourth target temperature at a fourth temperature rate (260). The fourth temperature rate ranges from 0.25 degrees F per minute to 20 degrees F per minute. The result is a piece of drilling equipment, without fractures and enhanced structural characteristics (270).

[00029] The treated device without fractures can be used in the intended purpose, and as parts of other earth moving equipment, such as back hoes, loaders, pumps, cutters and saws.

[00030] In one embodiment, the device can be treated using a first temperature rate and a second temperature rate that are substantially the same. Alternatively, the method will work if all temperature rates are different within the assigned ranges.

[00031] In an alternative embodiment, the device can be further treated by a third cycle. FIG 3 depicts steps of producing a thermally treated device using three thermal cycles the process resulting in a treated device without fractures and improved structural and metallurgical characteristics. More than three cycles can be applied to the device.

[00032] In the third cycle, the cryogenic material is added to the thermal control apparatus to decrease the device temperature while preventing over-stressing of the device (320). The device temperature is reduced to a fifth target temperature ranging from -40 degrees F to -380 degrees F at a fifth temperature rate (330). The fifth temperature rate ranges from 0.25 degrees F per minute to 20 degrees F per minute. When the fifth target temperature is reached, the cryogenic material is no longer introduced into the chamber (340).

[00033] The third cycle continues by increasing the chamber temperature to a sixth target temperature and, thereby, increasing the device temperature to the sixth target temperature ranging from 0 degrees F to 1400 degrees F (350). The temperature

increase is done at a sixth temperature rate ranging from 0.25 degrees F per minute to 20 degrees F per minute (360) resulting in a piece of drilling equipment, without fractures and enhanced structural characteristics (270).

[00034] The treated device described can be used for drilling bits and mining equipment, as well as for swords and metals needed for extreme temperatures, such at high subsea pressures. The treated device can also be used in the extremes of high altitude, such as, in airplanes, jets, on satellites and other materials used in space.

[00035] In another embodiment, the first temperature rate is used to create one or more of a set of desired metallurgical characteristics in the treated device. For example, the first temperature rate can cause improved wear resistance and the second temperature rate can cause improved impact resistance. Alternatively, the metallurgical characteristics can be hardness, strength, and combinations of these properties.

[00036] Overstressing within the context of this application refers to the act of causing fractures in the device or treated device material. The present method is designed to treat the device without causing fractures and related stress defects in the material while causing other advantageous metallurgical characteristics.

[00037] The method used to treat the device of the drilling equipment can have a first, second, third and fourth temperature rates which are determined by the mass of the device.

[00038] The device can be a composite of many parts, such as pistons, rings, pumps, bearings, actuators, lifters, clamps cams, or combinations thereof. The device of can be a part of a larger machine or device such as an engine, transmission, or drilling rig. Alternately, the device can be a stand alone tool dependent on no other for function.

[00039] While this piece of drilling equipment has been described with emphasis on the preferred embodiments, it should be understood that within the scope of the appended claims the piece of drilling equipment might be practiced other than as specifically described herein.